SCIENCE

VOL. 94 FRIDAY, DECEMBER 5, 1941 No. 2449

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SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

Lancaster, Pa. Garrison, N. Y.

New York City: Grand Central Terminal

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary in the Smithsonian Institution Building, Washington, D. C.

THE SIGNIFICANCE OF CHOLINE AS A DIETARY FACTOR[1]

By Professor C. H. BEST

THE UNIVERSITY OF TORONTO

IT is particularly appropriate so soon after the very tragic death of my colleague, Sir Frederick Banting, to emphasize the fact that the choline investigations which have already yielded many results of physiological significance, and promise more, are a direct outgrowth of the discovery of insulin. In the light of our present knowledge it was fortunate that, when Professor Macleod and his group initiated studies in which they observed insulin-treated depancreatized animals for several years, an adequate diet was not always used. A great deal of knowledge of the accessory food factors and of other aspects of nutrition has, of course, accumulated since that time. The depancreatized dog suffers from the loss of several of the digestive ferments, and the absorption of food material from the intestine is seriously impaired.

When Allan, Bowie, Macleod and Robinson in Toronto, and Fisher in Chicago noted large yellow livers in the insulin-treated animals, many possible explanations suggested themselves. When it was found that the abnormal condition could be prevented by the inclusion of raw beef pancreas in the diet, it became apparent that some constituent of this tissue was responsible for the improvement. Dr. Hershey,

[1] Abbreviated version of the paper given at the University of Chicago Fiftieth Anniversary Celebration, September, 1941.

first alone and later with Dr. Soskin, working in Professor Macleod's laboratory, studied the effects of feeding crude egg-yolk "lecithin" to the diabetic dogs receiving the diet which favored the production of fatty livers and it became apparent as one watched subsequent experiments that the phospholipid mixture was effective in a manner similar to that of pancreas. The logical inference was, therefore, that the phospholipid fraction or some unidentified substance associated with this material in the pancreas was responsible in part at least for the effect on liver fat.

Experiments on depancreatized dogs are extremely tedious and, in studies of this type, unless a large number of animals are observed, the results are difficult to interpret. In an effort to enlarge more speedily our knowledge of the factors which control fat deposition in the liver, Miss Huntsman, Dr. Hershey and I[2] decided to make studies on the white rat. We investigated the effect of, first, a crude and then a highly purified lecithin on the fatty livers which we found could be produced in the rats by feeding a diet very rich in fat. Purified lecithin turned out to be effective in preventing these fatty livers and sometime later[3] we established the fact that the active constituent of the lecithin was choline. More recently it has been found that as little as 1 mg per rat per day is an effective dose. When given in sufficient amounts to diabetic dogs, choline prevents the development of fatty livers and alleviates the condition when it is administered in curative experiments.[4] It has been shown, however, by Dragstedt and his colleagues that other factors contribute to the effect of the pancreas. This aspect of the subject will be referred to again later. By using a diet which contained much less choline than the mixed ration which previously had been provided, we were able to demonstrate an even more dramatic effect of choline on liver fat in both rats and depancreatized dogs.

In subsequent experiments with Dr. Ridout and Dr. Channon,[5] it was shown that the feeding of choline prevented the deposition of neutral fat and to a lesser extent that of the cholesterol esters in the livers of animals receiving pure cholesterol in their diets. It thus appeared that choline might be involved in the metabolism of cholesterol as well as in that of neutral fat. In curative experiments choline accelerated the removal of cholesterol esters as well as neutral fat from the liver.

The mechanism of the lipotropic action of choline. To describe the action of choline in the prevention and cure of fatty livers, I suggested some years ago that the term "lipotropic" be used. This has now come into fairly general use and serves to distinguish the effect of choline on fat metabolism from its other physiological actions.

In the very early experiments it was considered possible that choline acted through the formation of phospholipids. Although estimations of phospholipids showed no increase in the amount of these substances in liver tissue, it was realized at that time that there might be a more rapid "turnover" and that this could happen without an increase in the amount present. The first proof that this actually takes place was obtained by Dr. Arnold Welch, who conducted a very ingenious experiment in which he fed arseno-choline (which was lipotropic), and subsequently studied the arsenic content of the phospholipids. He obtained excellent evidence that the dietary substance had entered into combination with the other components of the phospholipid molecule.[6] Chaikoff and his collaborators at Berkeley used radioactive phosphorus as a tracer substance, and their analyses show quite convincingly that choline and the other lipotropic factors accelerated the rate of formation of phospholipids in the liver and other tissues.[7] More recently Stetten obtained similar results by labeling the choline molecule with heavy nitrogen. He was able to detect a high concentration of the isotopic nitrogen in pure choline isolated from the bodies of the choline-fed animals.[8] These results taken together leave little doubt that the mechanism by which the lipotropic effect is produced is by the stimulation of phospholipid interchange between the liver and other tissues. Stetten and Chaikoff found that the liver appeared to be the most active of the various organs.

Casein and methionine as lipotropic factors. The lipotropic effect of dietary casein was first noted by Miss Huntsman and myself in 1935. Tucker and Eckstein in 1937 demonstrated that methionine exerted a lipotropic action, both the d and l-methionine being effective. There is still some doubt as to whether casein owes its entire lipotropic action to its methionine content. It is well established that cystine exerts effects on liver fat which are antagonistic to those of choline and methionine.

The work of du Vigneaud and his colleagues. In 1939, du Vigneaud, Dyer and Kies found that homocystine or homocysteine was not capable of supporting growth in rats on an amino acid diet devoid of methionine and cystine, and supplemented with thia-

[2] C. H. Best, J. M. Hershey and M. E. Huntsman, *Jour. Physiol.*, 75: 56–60, 1932.

[3] C. H. Best and M. E. Huntsman, *Jour. Physiol.*, 75: 405–12, 1932.

[4] C. H. Best, G. C. Ferguson and J. M. Hershey, *Jour. Physiol.*, 79: 94–102, 1933.

[5] C. H. Best, H. J. Channon and J. H. Ridout, *Jour. Physiol.*, 81: 409–21, 1934.

[6] A. DeM. Welch, *Proc. Soc. Exp. Biol. and Med.*, 35: 107–8, 1936.

[7] I. Perlman and I. L. Chaikoff, *Jour. Biol. Chem.*, 127: 211–20, 1939.

[8] DeW. Stetten, Jr., *Jour. Biol. Chem.*, 138: 437–8, 1941.

min, riboflavin, nicotinic acid and ryzamin B as a source of the other B-factors. Rose and Rice found that with better sources of B-factors, growth was satisfactory, indicating that the milk concentrate or tikitiki which they used contained some substance which made possible the utilization of homocystine by rats on a diet deficient in methionine. Very soon after these reports, du Vigneaud, Chandler, Moyer and Keppel[9] proved that choline enables the rat to utilize homocystine for growth purposes, presumably by making possible the *in vivo* methylation of homocystine to methionine. Betaine, which Huntsman, Ridout and I had previously shown to be lipotropic, had an effect similar to choline on the methylation of homocystine.

In a subsequent study, du Vigneaud, Chandler, Cohn and Brown[10] fed methionine labeled with deuterium to immature rats on a diet free from methionine and choline. Choline and creatine isolated from the bodies of these animals contained such a high concentration of the isotope that it is questionable whether any other sources of methyl groups existed in the diet or tissues. Thus this process of "transmethylation" from choline to homocystine and from methionine to choline is established and bids fair to be of tremendous importance in many fundamental biological processes.

The recent finding of Stetten[11] that ethanolamine is a precursor of choline in the body gives promise of further interesting developments. Ethanolamine under the conditions it has thus far been tested, is not lipotropically active, but from the work of du Vigneaud and of Stetten, it does receive methyl groups from methionine to form choline.

Griffith's work on the relation of choline to hemorrhagic degeneration of the kidneys in young rats. Additional evidence of the importance of dietary choline has been provided by the studies of Griffith and his collaborators, who noticed hemorrhagic degeneration of the kidneys in young male rats which were fed on diets containing an apparently adequate amount of protein, and dietary essentials other than choline. These young animals, which were from 21 to 26 days of age, developed the characteristic fatty livers which have been referred to above, within 48 hours. Griffith noted in addition to the fatty livers, severe hemorrhagic degeneration of the kidneys, ocular hemorrhages and a regression of the thymus gland. Griffith[12] and Griffith and Mulford[13] have shown that the hemorrhagic degeneration is prevented by methionine and betaine as well as by choline. It is aggravated by feeding cystine or cholesterol. In a recent article Griffith and Mulford,[14] have emphasized the fact that the renal changes or the fatty livers do not appear if the food intake is restricted. Griffith has also suggested that the rate of metabolism or of growth may be the basis for the apparent antagonism between choline and cystine, and suggests that on diets which are inadequate in the S-containing amino acids added cystine improves the nutritional state, and for this reason, extra choline is required.

The mechanism by which choline and the other lipotropic factors prevent these hemorrhagic lesions in the kidney and other organs is not well established. The fact, however, that the lesions are augmented by cystine and by cholesterol and prevented by the naturally occurring lipotropic factors choline, betaine and methionine makes a picture so similar to that seen in the studies on the liver that it seems reasonable to assume that the same or a very closely related mechanism is operating.

Jukes' work on the relation of choline to avian nutrition. Under certain experimental conditions, a shortening and thickening of the bones, particularly noticeable in the tarsus and tibia of young birds, is produced when certain diets are provided. This condition is known as perosis. In many cases a distortion and dislocation of the hock joint results, and the slipping of the tendo calcaneus has provided the basis for the term "slipped tendon" disease. In 1936 it was shown that perosis may be caused by a deficiency of manganese. In 1940, however, Jukes[15] showed that when the supply of manganese was adequate, perosis was not prevented unless choline was also supplied in the diet.

The effect of choline in preventing perosis has been observed in both chicks and young turkeys. There is a very interesting interrelationship between choline and glycine deficiency in so far as perosis is concerned. On a diet deficient in both choline and glycine, perosis does not appear in chicks. If glycine is added to the diet, perosis is produced and if choline is then given, the condition is alleviated.[16]

Jukes has suggested as a possible explanation for these observations on the effects of choline and glycine that the glycine, which is a precursor of creatine, prevents the appearance of muscular dystrophy. The perosis is not seen in the presence of the muscular dystrophy presumably because there is less pull of the muscles on the bones in this condition. Creatine will produce perosis when added to a diet deficient in both glycine and choline.

[9] V. du Vigneaud, J. P. Chandler, A. W. Moyer and D. M. Keppel, *Jour. Biol. Chem.*, 131: 57–76, 1939.
[10] V. du Vigneaud, J. P. Chandler, M. Cohn and G. B. Brown, *Jour. Biol. Chem.*, 134: 787–8, 1940.
[11] DeW. Stetten, Jr., *Jour. Biol. Chem.*, 140: cxxvii, 1941.
[12] W. H. Griffith, *Jour. Nutrition*, 21: 291–306, 1941.
[13] W. H. Griffith and D. J. Mulford, *Jour. Am. Chem. Soc.*, 63: 929–32, 1941.
[14] *Ibid., Jour. Nutrition*, 21: 633–45, 1941.
[15] T. H. Jukes, *Jour. Nutrition*, 20: 445–58, 1940.
[16] *Ibid., Jour. Nutrition*, 21: P13, 1941.

Jukes has obtained evidence by adding certain analogues of choline to diets deficient in this substance, that the growth-promoting and anti-perotic properties of choline are truly distinct. He has found that methyl-diethyl-choline and beta-methyl-choline will protect against perosis but do not promote growth. On the other hand, betaine and betaine aldehyde promote growth but are devoid of anti-perotic activity for chicks. These results link choline with the metabolism of either muscle or bone—perhaps with both.

The work of McHenry and his colleagues. In 1935, Best, Huntsman, McHenry and Ridout[17] reported a favorable influence of choline on the gain in weight of young rats receiving a diet low in lipotropic factors and rich in fat. Subsequently McHenry and his colleagues working independently in my department have made several extremely important additions to our knowledge of the choline field. In 1936, McHenry[18] reported an apparent relationship between thiamin and choline in the production of fatty livers. In thiamin deficient animals, without thiamin in the diet, fat does not accumulate in the liver in the absence of dietary lipotropic factors unless liberal amounts of fat are supplied. With thiamin and without fat in the diet, fat formed from carbohydrate is deposited in the liver. This fat is rich in glycerides and low in cholesterol and its deposition is prevented by the administration of small amounts of choline. Other members of the B-complex, riboflavin and pyridoxine, also increase the deposition of fat in the liver but not unless thiamin is also supplied.[19] An interesting question has been raised by Griffith. Is the thiamin-choline antagonism a specific one, or is the action of thiamin merely to raise the "level of nutrition" to a point where choline can act? Animals receiving a low caloric intake do not show signs of choline deficiency when an abundance of thiamin is available. On the other hand, the only way in which the nutritional state of an animal suffering from thiamin deficiency can be restored to normal is by providing the specific substance. The fact, however, that diets rich in fat produce fatty livers in the absence of thiamin, may suggest an answer to one aspect of the problem. It is obvious that if fat is not presented sufficiently rapidly to the liver to produce an accumulation, the action of choline in preventing this can not be demonstrated. Food intake, particularly fat intake, and the conversion of sugar to fat, presumably in the liver under the influence of thiamin, will work together to control the amount of substrate upon which choline acts. The ability of the liver cells to metabolize the fat depends, of course, on other factors as well as on the concentration of the lipotropic substances available.

The effect of choline upon the deposition of fat produced by chemical agents or by hormones. When fatty livers are produced by phosphorus poisoning or by one of the many other chemicals which have this effect, the deposition of fat is not prevented by the lipotropic factors. It is true, however, that the rate of disappearance of the fat from the phosphorus poisoned liver is accelerated when choline is supplied.[20] The same is true of the fatty liver produced by carbon tetrachloride poisoning.[21] Neither the acute fatty liver produced by the factor in the anterior pituitary gland,[22] nor the deposition of cholesterol and neutral fat caused by the feeding of biotin[23] is readily affected by choline. It is thus apparent that there are various types of fatty liver, and that those upon which the lipotropic factors act with characteristic rapidity are produced by a deficiency of these substances in the diet.

The preliminary work of Solandt on acetylcholine production. Several years ago, D. Y. Solandt and I discussed repeatedly the possibility that choline as a dietary factor might control the amount of neurohumor, acetylcholine available. While the results of preliminary work along this line were not satisfactorily consistent, it was found in some series that stimulation of the vagus nerve produced less effect in choline-deficient rats than in controls receiving the same ration plus choline.[24] Furthermore, it was possible to restore the vagus effect by the intravenous injection of choline in these animals. This problem demands a great deal of further work, but if a definite connection between the amount of choline or its precursors in the diet and the liberation of acetylcholine can be established, this will become one of the most important aspects of this subject.

The work of Dragstedt and his collaborators on the prevention of fatty livers in depancreatized dogs. The work of Dr. Dragstedt and his colleagues on lipocaic is undoubtedly closely related physiologically to the studies on choline. It now appears certain, however, that the active material in which Dr. Dragstedt is particularly interested is not choline. My colleague, Dr. McHenry, has suggested that the activity of lipocaic in rats may be in part due to inositol, but we are all agreed that the experiments on normal

[17] C. H. Best, M. E. Huntsman, E. W. McHenry and J. H. Ridout, *Jour. Physiol.*, 84: 38P, 1935.
[18] E. W. McHenry, *Jour. Physiol.*, 86: 27P–28P, 1936.
[19] G. Gavin and E. W. McHenry, *Jour. Biol. Chem.*, 132: 41–46, 1940.
[20] C. H. Best, D. L. MacLean and J. H. Ridout, *Jour. Physiol.*, 83: 275–84, 1935.
[21] H. M. Barret, C. H. Best, D. L. MacLean and J. H. Ridout, *Jour. Physiol.*, 97: 103–6, 1939.
[22] C. H. Best and J. Campbell, *Jour. Physiol.*, 92: 91–110, 1938.
[23] E. W. McHenry and G. Gavin, *Jour. Biol. Chem.*, 140: lxxxvii, 1941.
[24] D. Y. Solandt and C. H. Best, *Nature*, 144: 376, 1939.

rats do not necessarily yield results which can be applied to the depancreatized dog. It may be that inositol is one of the active constituents of lipocaic which affects depancreatized dogs, or it may be that other active fractions are present. The extracts of pancreas, as McHenry and Gavin have shown, affect the fatty liver produced by feeding biotin. This "biotin" fatty liver is characterized by a high content of cholesterol as well as of neutral fat. Choline affects cholesterol esters more slowly than neutral fat, and very large doses are required. The action of some active principle in lipocaic is much more rapid.

McHenry has advanced reasons for believing that the fatty liver of the depancreatized dog is of the biotin type. Without doubt there is evidence that cholesterol esters are deposited in increased amounts in the fatty liver of the depancreatized dog. Ralli and her collaborators[25] did not obtain fatty livers in depancreatized dogs fed on a diet from which the biotin fraction was presumably in part extracted. On the other hand, I feel that there is also good evidence that the fatty liver of a depancreatized dog is of the type due to the deficiency of choline. It is quite probable that both types may exist together.

It is important to emphasize the fact here that in the absence of the pancreatic enzymes, the amount of dietary choline, methionine or of other lipotropic factors absorbed from the intestine may be appreciably diminished, and this situation may in part be corrected by providing the pancreatic enzymes in the diet. We have emphasized this possibility previously and Chaikoff, quite independently, has stressed the same point.

Dr. Dragstedt feels that he will eventually convince even the most skeptical that lipocaic is a second internal secretion of the pancreas. I suppose this would be even more interesting than the demonstration that another dietary factor is involved in the prevention of fatty livers in depancreatized dogs. I would like to take this opportunity to wish Dr. Dragstedt and his colleagues every success in their further work.

In review, let me outline the main trends of the choline investigations. It is apparent that choline is a growth factor; it profoundly affects fat transport and more indirectly carbohydrate metabolism; it may be formed when the methyl groups of methionine are presented to ethanolamine; it provides methyl groups for homocystine and perhaps for other substances; it is thus involved in protein metabolism. It prevents hemorrhagic kidney degeneration and other lesions in young rats and perosis in chicks and turkeys. Lastly, it is *one* of the factors in pancreas which prevents the development of fatty livers in depancreatized dogs.

In this article I have not attempted to do more than to sketch a picture, the details of which can not be filled in at this time. There are many gaps in my presentation of the known facts, but it will perhaps serve to indicate the possibilities of augmenting our knowledge of fat metabolism by further studies on choline and the other lipotropic factors.

[25] E. P. Ralli and W. H. Rubin, *Proc. Soc. Exp. Biol. and Med.*, 43: 601–3, 1940.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

PRELIMINARY ANNOUNCEMENT OF THE DALLAS MEETING

II

Edited by Dr. F. R. MOULTON

PERMANENT SECRETARY

SECTION AND SOCIETY PROGRAMS

Section on Mathematics (December 29, 30) on Monday morning will hold a joint session with the Institute of Mathematical Statistics and the Econometric Society. In the afternoon A. B. Coble, of the University of Illinois, will deliver his address as retiring vice president for the section on "A Certain Set of Ten Points in Space." The sessions on Tuesday will be for the presentation of contributed papers.

Section on Physics and the American Association of Physics Teachers (December 29, 30) will hold four sessions for the presentation of papers. On Monday morning the society will hold a session at which four contributed papers will be presented. On Monday afternoon the section and the society will hold a joint session at which Arthur L. Hughes, chairman of the section, will deliver his address as retiring vice president of the association on "Applications of Electron Scattering." Following the address of Dr. Hughes, V. K. Zworykin and J. Hillier will present a paper on "Stereo-Microscopy with the Electron Microscope" and A. Glenn Richards, Jr., and Thomas F. Anderson will present their results on "Electron Micrograph Studies of Insect Structures."

The program on Tuesday will consist of two joint sessions at which only invited papers will be presented.

Section on Chemistry (December 29–31) will present three symposia under the chairmanship of Dr. Edward A. Doisy, vice president of the association for the section, and join in a dinner on Monday evening in honor of Dr. George Scatchard, who will deliver an address as a retiring vice president of the association on "The Applications of Physical Chemistry to Biological Problems."

"Biochemistry" is the subject of the first symposium, at which 10 papers will be presented. They pertain to such subjects as manifestations of nutritional deficiencies, recent work on the vitamin B complex, amino acids and clinical effects of several vitamins, hormones and amino acids on tumors in rodents and inoperable tumors in man.

The second symposium is on "Spectrographic Analysis," at which 11 papers will be presented. They range from applications in the steel industry to determining the constitutions of the stars. They include contributions to such subjects of theoretical and practical interest as spectro-chemical methods for non-metallic analysis, ultraviolet absorption in organic molecules, the photoelectric spectrophotometer and gas analysis with the mass-spectrometer.

The third symposium is on the "Petroleum Industry," at which 9 papers will be presented. They cover chemical and geological aspects of the subject widely from the question of the origin of oil pools to the utilization of petroleum products in industry and in national defense.

Section on Astronomy (December 30, 31) will hold four sessions, primarily for the presentation of invited papers, including "Photometry of the Night Sky," by C. T. Elvey, of the McDonald Observatory; "Time Determination and Time Keeping," by Paul Sollenberger, of the Time Service of the U. S. Naval Observatory; "Problems of Nebular Research," by Edwin P. Hubble, of the Mount Wilson Observatory; "Progress in Eclipse Work," including colored moving pictures of the 1940 expedition to Brazil, by Paul A. McNally, of the Georgetown College Observatory; "Stellar Photometry," by L. V. Robinson, of the University of Mississippi; "Solar-Terrestrial Relationships," by H. T. Stetson, of the Massachusetts Institute of Technology, and "Progress in Planetary Research," by E. C. Slipher, of the Lowell Observatory. In addition, there will be a symposium on "Problems of Teaching Astronomy with Special Reference to Observational and Demonstration Equipment." An illustrated lecture on the planets with special attention to the recent close approach of Mars to the earth will be delivered by E. C. Slipher, of the Lowell Observatory. Robert R. McMath, chairman of the section, will deliver his address as retiring vice president of the association.

Section on Geology and Geography (December 29–31) in cooperation with the Geological Society of America, the American Geophysical Union, the Texas Academy of Science, the Dallas Petroleum Geologists, the Fort Worth Geological Society and the Association of American Geographers, will hold 6 sessions at which 40 papers will be presented.

On Monday, the morning session will be devoted to general geologic papers and to addresses by Charles N. Gould and Elmer H. Johnson, who will review contributions made by scientists from the southwestern states to geology and geography. Then will follow the feature of the session, the address by Hugh D. Miser, retiring vice president of the association and chairman of the section, on "Quartz Veins of the Ouachita Mountains of Arkansas and Oklahoma."

A symposium on the "Stratigraphy and Structure of the Southwest," arranged by a committee of which Charles L. Baker, of Texas A. and M. College, is chairman, will be held on Monday afternoon. Eight papers dealing with fundamental field problems of sedimentation and tectonics will be presented.

On Tuesday morning, under the joint sponsorship of the section and the American Geophysical Union, the work carried on for several years in the southwestern states by the Ground-Water Division of the U. S. Geological Survey and cooperating agencies will be reviewed. At this session a series of invited papers will be presented. The symposium will be introduced by O. E. Meinzer, who will outline the various types of problems which the subsequent papers will illustrate and elaborate.

On Tuesday afternoon the section will join with the Section on Anthropology for a series of papers on the present status of knowledge regarding Early Man. Representatives of the two sections have cooperated in the development of this program. A coordinated series of exhibits is being planned.

The geographic session on Wednesday has been developed by a committee of which Edwin J. Foscue, of Southern Methodist University, designated as the representative of the Association of American Geographers, is chairman. Six major papers will deal with geographic problems in the Southwest, ranging in scope from demography to land-use. It is tentatively planned that the papers will be followed by a round-table discussion on Southwestern Geography.

The Houston Geological Society has been invited to display its remarkable exhibit on petroleum geology. The committee which planned the Early Man symposium is also projecting an exhibit of artifacts and faunal associations. Other exhibits of geological and geographical materials and of teaching techniques are in preparation.

Section on Zoological Sciences (December 30) will

join with its affiliated societies in their programs and in the annual dinner of the American Society of Zoologists, after which John T. Patterson, chairman of the section, will deliver an address as vice president of the association, on "Drosophila and Speciation."

American Society of Zoologists (December 29–31) will participate with other societies in holding three symposia and in sponsoring the Biologists' Smoker, and on Tuesday evening it will hold its annual dinner to which all zoologists and friends are invited.

On Monday morning the society will hold a symposium on "The Genetic Control of Embryonic Development," at which papers will be presented by V. C. Twitty, of Stanford University, V. Hamburger, of Washington University, and Sewall Wright, of The University of Chicago. On Monday afternoon the society, in cooperation with the Botanical Society of America, the Ecological Society of America and the Genetics Society of America, will hold a symposium on "Isolating Mechanisms," at which papers will be presented by C. Ledyard Stebbins, Jr., of the University of California, Albert P. Blair, of Tulsa, Oklahoma, Alfred C. Kinsey, of Indiana University, and John T. Patterson, of the University of Texas.

The society, the Botanical Society of America and the Ecological Society of America will hold a symposium on "Temperature and Evolution" in two joint sessions, the former on Tuesday morning and the latter on Wednesday morning. At the Tuesday morning session papers will be presented by H. H. Plough, of Amherst College, G. Fankhauser, of Princeton University, George P. Child, of Amherst College, and Emil Witschi, of the University of Iowa. At the Wednesday morning session papers will be presented by H. J. Muller, of Amherst College, Walter Landauer, of the University of Connecticut, Alfred C. Kinsey, of Indiana University, and John A. Moore, of Queens College.

In the final session on Wednesday afternoon the society will participate with the American Society of Naturalists, the Genetics Society of America and the Botanical Society of America in holding a symposium on "Human Genetics," which was organized by Laurence H. Snyder, of Ohio State University. The contributors to this symposium are Laurence H. Snyder, of Ohio State University; H. H. Strandskov, of The University of Chicago; Charles W. Cotterman, of the University of Michigan; and L. S. Penrose, of Ontario Hospital.

American Society of Parasitologists (December 29–31) will present a program consisting of 58 papers and demonstrations representing the fields of protozoology, helminthology and medical entomology. At the Tuesday morning session, at 11 o'clock, James E. Ackert, president of the society, will deliver an address on "Natural Resistance to Helminthic Infections." On Tuesday noon the society will hold a luncheon, followed by its annual business meeting. At the demonstration program on Tuesday afternoon tea will be served.

The Section on the Botanical Sciences (December 30) will hold a joint session on Tuesday afternoon with the Botanical Society of America, American Phytopathological Society, American Fern Society, Sullivant Moss Society, Mycological Society of America and American Society of Plant Taxonomists, at which M. L. Fernald, chairman of the section, will deliver his address as retiring vice president of the association on "Some Historical Aspects of Plant Taxonomy." The remainder of the session consists of invited papers by R. W. Chaney, W. H. Camp and L. J. Stadler on "Plant Distribution During the Past Fifty Million Years," "The Individual in Relation to Complex Populations in *Vaccinium*," and "Some Experiments in Gene Mutation," respectively.

Botanical Society of America (December 29–31) has organized programs for the presentation of papers under the General, Paleobotanical, Physiological and Systematic Sections of the society. In addition, the society will hold two symposia on the teaching of plant science, and it will join with other societies in symposia on "The Origin and Development of Floras of the Southwest," "Isolating Mechanisms," "Temperature and Evolution," and "Experimental Design and the Control and Measurement in Physiological Investigations."

The American Phytopathological Society (December 29–January 1) will hold its 33d annual meeting at the Hotel Adolphus. The program will consist of six sessions of the society for the presentation of papers, one demonstration session, three joint sessions with other societies for the presentation of papers, three conferences on special subjects and the annual dinner of the society on Tuesday evening. A distinguished foreign colleague, Dr. A. A. Bitancourt, of the Instituto Biologico de São Paulo, Brazil, will present a paper on "New Species of Sphaceloma on Myrtaceae." Dr. Bitancourt has been a member of the association since 1934.

The program of the society will begin with a business meeting on Monday morning, followed by three simultaneous sessions in the afternoon for discussions of "Fungicides and Fruit Diseases," "Virus and Tobacco Diseases" and "Small Grain Diseases," respectively. A conference on "Quarantines in Relation to Virus Diseases" is tentatively scheduled for the evening. On Tuesday morning two simultaneous sessions are planned for the consideration of "Corn and Sorghum Diseases" and "Truck Crop Diseases." On Tuesday afternoon the society will hold a joint ses-

sion with the Section on Botanical Sciences and simultaneously a conference sponsored by the extension plant pathologists on "Plant Pathology in Relation to National Defense and Post-war Readjustments." On the same afternoon a demonstration session will be held.

On Wednesday afternoon the society will hold a joint session with the Potato Association of America and a conference on "Seed Treatment Experiments" under the direction of the Committee for Coordination of Research in Cereal and Vegetable Seed Treatments. Reports will be presented on vegetable seed treatments, cotton seed treatments and cereal seed treatments. In addition, tentative plans have been made for a simultaneous session on "Forest Tree Diseases," followed by a session on diseases of southern and miscellaneous crops.

Members of the American Phytopathological Society will present approximately 103 papers at these sessions.

The Mycological Society of America (Dec. 30) will hold a session on Tuesday morning at which Ernst A. Bessey will deliver his presidential address on "Some Problems in Fungus Phylogeny." The society will present three symposia: (1) "Soil Fungi and their Activities," (2) "Fungi Pathogenic to Man and Animals" and (3) "Sex and Genetics of Fungi."

Sullivant Moss Society (December 31) will hold a session in both the morning and the afternoon for the presentation of papers.

The American Fern Society (January 1) will hold a session on Thursday morning, at which Joseph Ewan, president of the society, will deliver an address on "Problems Suggested by Field Work with the Aquatic Pteridophyta of Colorado." On Tuesday afternoon the society will join in the meeting of the Botanical Society of America.

American Society of Plant Taxonomists (December 29–31) will join with the Systematic Section of the Botanical Society of America in a session for the presentation of papers and will hold its annual dinner on Monday evening.

American Society of Naturalists (December 30, 31) will hold a joint session on Wednesday afternoon with related zoological and botanical sciences at which a symposium on "Human Genetics" will be presented. This symposium, consisting of 4 papers, was organized by Laurence H. Snyder. On Wednesday evening the society will hold the annual Naturalists' Dinner, at which W. W. Cort will deliver his presidential address on "Human Factors in Parasite Ecology." In conformity with custom, the society will arrange for the annual Biologists' Smoker, which will be held on Tuesday evening.

Ecological Society of America (December 29–31) on Monday afternoon will hold a joint session with the American Society of Zoologists, the Botanical Society of America and the Genetics Society of America in a symposium on "Isolating Mechanisms." On Tuesday and Wednesday mornings the society will join the American Society of Zoologists in sponsoring a symposium on "Temperature and Evolution." A joint session with the Limnological Society of America will be held Tuesday afternoon. The annual banquet of the society, to which all interested biologists are invited, will be held on Monday evening, at which A. E. Emerson, the retiring president of the society, will speak.

The Genetics Society of America (December 29-31) will hold two symposia, two sessions for the presentation of papers, one session for a demonstration program and, at Tuesday noon, its annual luncheon and business meeting.

On Monday afternoon the society will join the American Society of Zoologists, the Botanical Society of America and the Ecological Soicety of America in holding a symposium on "Isolating Mechanisms," under the chairmanship of John T. Patterson, vice president of the association for the Section on Zoological Sciences. On Wednesday afternoon the society will participate in the symposium on "Human Genetics," which will be held under the chairmanship of W. W. Cort, and at which papers will be presented by L. H. Snyder, H. H. Strandskov, C. W. Cotterman and L. S. Penrose. At a special invitation program papers will be presented by G. B. Mainland, G. W. Beadle and E. L. Tatum, H. Roman, T. M. Sonneborn, A. W. Pollister and A. E. Mirsky and J. S. Gowen.

The American Microscopical Society (December 29) will hold its executive luncheon at noon and its annual business meeting at 4 P.M.

The Limnological Society of America (December 29–31) will hold its seventh annual meeting at Dallas. Both society headquarters and session meetings will be in the Jefferson Hotel. The first two days, Monday and Tuesday, are reserved for programs for the presentation of research papers. The session of Tuesday afternoon will be a joint meeting with the Ecological Society of America. Forty papers are to be presented during the two days; in addition, 13 papers appear on the program to be read by title only. The program for Monday forenoon and afternoon consists of papers of general limnological interest; that for Tuesday forenoon is composed largely of papers dealing with limnology as related to the various problems of fish and fisheries biology. On the program for the joint meeting with the Ecological Society will appear limnological papers having very general interest. The annual business meeting

of the society will occur at the close of the Tuesday forenoon session. Wednesday will be devoted to an all-day field trip to Eagle Mountain Lake and other points of limnological interest, under the leadership of local limnologists.

National Association of Biology Teachers (December 29) will hold two sessions for the presentation of papers and a dinner in the evening at which Walter F. Loehwing, of the University of Iowa, will deliver an address. The ten contributed papers cover a wide range of subjects of interest to teachers of biology.

Phi Sigma Society (January 1, 2) will hold sessions for the presentation of papers and a dinner, probably on Friday evening.

Beta Beta Beta Honorary Biological Fraternity (December 31) will have a luncheon on Wednesday in the Hotel Adolphus, after which Dr. C. E. McClung, president of the society, will deliver an address, at the conclusion of which a business session will be held.

Union of American Biological Societies (December 29) will hold its annual business meeting on Monday at 4 P.M.

Section on Anthropology (December 29, 30) will hold four sessions at which two major themes will be stressed: the archeology and culture areas of the Southeastern United States; and problems relating to early man with special reference to North America. The symposium on "Early Man" will be held jointly with the Section on Geology and Geography at the Tuesday afternoon session. E. B. Howard will outline the present status of the Folsom-Yuma problem. E. B. Sellards will discuss terrace deposits in the chronology of early man. R. M. Adams will report on early man in Missouri; A. O. Bowden and I. A. Lopatin, in California; C. W. Cooke, in Florida; M. S. Goldstein and G. L. Evans, in Texas, and F. C. Hibben, in Alaska. Contributors to the discussion of the Southeastern United States will include anthropologists from the Universities of Texas, Tennessee and Kentucky. There will be one session devoted to anthropometry, with papers by E. W. Count, T. H. Evans and others. Dr. W. Duncan Strong, chairman of the section, will deliver an address as retiring vice president of the association.

Section on Psychology (December 29, 30) beginning on Monday morning will hold a symposium on "Recent Advances in the Appraisal of Personality" under the chairmanship of Ernest R. Hilgard, of Stanford University. The subject of the symposium was selected in conformity with the suggestion of President Blakeslee that the *leit motif* of the meeting in Dallas be "Individuality" so far as might be practicable. The participants in this symposium include Pearl Bretnall, of Tulane University; Doncaster G. Humm, of Los Angeles; Frank A. Peattie, of Rice Institute, and Dael Wolfle, of The University of Chicago.

On Tuesday the section will hold a joint symposium with the Section on Education on "The Psychology of Learning and the Educative Process," under the chairmanship of H. T. Manuel, of the University of Texas. The participants for the psychologists will be John A. McGeoch, of the State University of Iowa; Norman L. Munn, of Vanderbilt University, and Ernest R. Hilgard, of Stanford University. The participants representing the Section on Education will be A. A. Barr, of the University of Wisconsin; Harold F. Clark, of Columbia University, and H. Meltzer, of Psychological Service Center, St. Louis, Mo.

In addition to the symposia there will be two or more sessions for contributed papers.

The Section on Psychology and the Section on Education will join in a dinner on Tuesday evening at which Karl M. Dallenbach, chairman of the section, will deliver an address as a retiring vice president of the association. E. J. Ashbaugh, of Miami University, vice president of the association for the Section on Education, will also deliver an address.

The Section on Social and Economic Sciences (December 29–31) will present a program consisting of 6 sessions. The first session, in charge of a committee of Texas A. and M. College, will prepare the way for the 5 other sessions by presenting a general frame of information about the Southwest, including its human and natural resources and the changing pattern of its agricultural and industrial life. The second session, organized by A. B. Cox, of the University of Texas, will show how industry is developing in the Southwest and raising new problems.

The third and fourth sessions will be concerned with interracial problems, the former between Negroes and Whites and the latter between Spanish-Americans and Whites, that are arising because of the changing economy and conditions in Texas and adjacent territory. The former of these programs is under the charge of Daniel Russell, of Texas A. and M., and the latter is under the charge of George Sanchez, of the University of Texas.

One of the subjects of the fifth session, which is being organized in cooperation with the Office of Indian Affairs, will be the place of Indians in the economy of the Southwest and related problems. The final session, in charge of Earl O. Mills, regional counselor of the National Resources Planning Board, will be devoted to discussions of the plans that are being developed to meet the problems that are arising in the Southwest.

Metric Association (December 30) will hold a dinner meeting on Tuesday, at which there will be discussion

by the delegates from recently organized departments of the society, followed by its annual business meeting and discussion of plans for next year.

The National Social Science Honor Society, Pi Gamma Mu, Inc., (December 31) will hold its annual social science luncheon on Wednesday, at which brief addresses will be delivered.

The Section on Engineering (December 31) will hold two sessions for the delivery of addresses and the presentation of papers. At the morning session, Dean Robert L. Sackett, retiring vice president of the association, will deliver an address. It is expected that C. M. A. Stine, of the Du Pont Company, John Suman, president of the A. I. M. E., and Everett De Golyer, will present papers, and Ross White, chief engineer for dam construction for the TVA, will present a paper. Dr. M. J. Thompson will review the present status of the aeronautical industry and attempt to project present developments beyond the present emergency.

The Section on Medical Sciences (December 30, 31) will present a symposium on "Relapsing Fever" in human beings as it exists in the United States and the Canal Zone. Twenty papers will be presented, beginning with a biographical sketch of Otto Obermeier, who detected spirochetes that were later proved to be the causative agents of the European disease. Other papers will discuss the present distribution of relapsing fever in certain southern and western states, the taxonomy of the spirochete, its performance on laboratory media, tick vectors and various clinical and laboratory aspects of relapsing fever. It is expected that these papers will be published as one of the association's symposia volumes on important public health diseases.

In addition, the section will hold sessions on December 31 for the presentation of papers on diverse problems of medical interest. At one of these sessions, Dr. Ernest W. Goodpasture, chairman of the section, will deliver his address as retiring vice president of the association.

Subsection on Dentistry of the Section on Medical Sciences (December 29, 30) will present a symposium on "Public Health Aspects of Dentistry, with special Reference to Fluorine." Such authorities on the subject as Frederick S. McKay, H. T. Dean, Philip Jay, Isaac Schour, Wallace Armstrong, Gerald Cox and C. F. Deatherage will present papers on the program.

Subsection on Pharmacy of the Section on Medical Sciences (December 29) will hold morning and afternoon sessions on Monday for the presentation of papers.

American Society for Horticultural Science (December 29–31), beginning on Monday afternoon, will hold four joint sessions with other societies for the holding of symposia and the presentation of papers.

On Monday afternoon the Vegetable Section of the society will hold a joint session with the Potato Association of America for the presentation of papers on "Potato Breeding, Physiology and Production." On Tuesday morning the society will hold a joint session with the Section on Agriculture, at which W. H. Chandler, the chairman of the section, will deliver his address as retiring vice president of the association on "Forty Years of Helping the Farmer with Knowledge." At the same session several papers will be presented on various questions of reproduction and fruitfulness in horticultural plants.

On Tuesday afternoon the society will hold a joint symposium with the American Society of Plant Physiologists and the Physiology Section of the Botanical Society of America on "Experimental Design and Control and Measurement of Variation in Physiological Research." On Wednesday morning the society will join with the Biometrics Section of the American Statistical Association in holding a symposium on "Efficiency in Recent Methods for Controlling Field Heterogeneity."

At the annual banquet of the society on Tuesday evening F. C. Bradford, president of the society, will deliver an address on "Retaining What We Have."

Potato Association of America (December 29–31) will hold joint sessions with the American Society for Horticultural Science and with the American Phytopathological Society for the presentation of papers, in addition to independent sessions for the presentation of papers.

Section on Education (December 30, 31) will hold a joint session with the Section on Psychology, a symposium on conservation problems, which is being arranged by a local committee, a joint dinner, as usual, with the Section on Psychology and two sessions for the presentation of general papers.

At the joint session with the psychologists A. S. Barr, of the University of Wisconsin, will present a paper on "The Teacher and the Education Process"; Harold F. Clark, of Columbia University, on "The Effect of Diet on Learning"; and H. Meltzer, of Psychological Center, St. Louis, on "Education and the Learning Process." Among other participants in the program are Oliver S. Loud, of Teachers College; R. W. Lynch, of Oklahoma A. and M. College; and Stuart E. Noble, of Tulane University of Louisiana. Dr. Noble's paper will be on "Progress in the Elimination of Illiteracy in the South."

The Society of the Sigma Xi (December 30) will hold the business meeting of its forty-second annual convention on Tuesday afternoon. On Tuesday eve-

ning, in cooperation with the association, it will present as its speaker for its twentieth annual Sigma Xi Lecture Dr. Edwin P. Hubble, of the Mount Wilson Observatory, who will deliver an address on "The Expanding Universe Theory."

United Chapters of Phi Beta Kappa (December 31) on Wednesday evening will present as the speaker for its seventh annual Phi Beta Kappa lecture Dean Christian Gauss, of Princeton University, who will deliver an address on, "Can We Educate for Democracy?"

American Science Teachers Association (December 30) will hold sessions on Tuesday, the morning session jointly with the American Nature Study Society. On Tuesday noon the society will hold a luncheon at which Irving Langmuir, president of the association, will speak.

American Nature Study Society (December 30, 31) will hold four sessions for the presentation of papers and a breakfast on Wednesday morning. The session on Tuesday morning will be held jointly with the American Science Teachers Association, at which Irving Langmuir, president of the association, will speak.

The Honor Society of Phi Kappa Phi (December 30) will hold its biennial meeting at 1:30 P.M. on Tuesday and on Wednesday morning. On Wednesday a breakfast will be held at 8:00 A.M., followed by a short business session. At 5:00 P.M. on Wednesday the society will provide a public lecture by Dr. Rufus B. von KleinSmid, president of the University of Southern California and president of Phi Kappa Phi.

Gamma Alpha Graduate Scientific Fraternity (December 30) will hold a meeting of its executive committee on Tuesday morning, its convention luncheon on Tuesday noon and a business meeting of the council and the election of officers on Tuesday afternoon.

Sigma Delta Epsilon, Graduate Women's Scientific Fraternity (December 29–January 1) will hold its national council meeting on Monday morning, a luncheon for all women in science at noon on Tuesday, a breakfast and its annual business meeting on Wednesday morning and a second national council meeting on Thursday afternoon.

OBITUARY

CHARLES PECHER

IN the death of Charles Pecher at the age of twenty-eight experimental medicine has lost a brilliant investigator who already had made important contributions in the application of nuclear physics to biology and medicine.

Dr. Pecher was born in Antwerp, Belgium, on November 26, 1913, his father being the Minister of Colonies. In 1923 he graduated from the Athenée Royal of Antwerp, and in 1939 received his doctor's degree from the University of Brussels with great distinction. From 1935 to 1939 he was laboratory assistant in physiology under Professor Rylant, and it was during this period that he did his first experimental work in biophysics. Also during this time he became interested in the biological applications of the newly discovered radioactive substances. Because of his interest in this field and because of his high standing in his class at medical school (having been awarded the Armand Kleefeld Prize, which is awarded each year to the medical student who has had the highest average in his course) he was awarded the fellowship of the Belgian American Foundation to study in the United States.

During the fall of 1939 he worked in association with Professors Edwin Cohn, Kistiakowsky and J. Wyman at Harvard, and later in 1940 he came to the Radiation Laboratory at the University of California, where he was appointed research fellow.

Because of his thorough training in both physics and medicine, and due to his industry and brilliance, he soon made important contributions in the new field of artificial radioactivity. He was instrumental in putting on a practical basis the production of large quantities of radioactive yttrium, which proved to be very valuable as a gamma ray source for radiography of metallic flaws. He added much to our knowledge of calcium metabolism and in his work using radioactive strontium he showed that strontium acts physiologically in a manner similar to calcium in the animal body and because of its localization in bone is now being used experimentally in the treatment of neoplastic disease of bone. Mrs. Pecher assisted him in some of this work. At the time of his death, Dr. Pecher was serving with the Belgian Army in Canada, preparatory to embarkation to join the Belgian Army in England, and his death cut short the life of a young man who already had made lasting and worthwhile contributions to science.

JOHN H. LAWRENCE
CROCKER RADIATION LABORATORY,
UNIVERSITY OF CALIFORNIA, BERKELEY

DEATHS AND MEMORIALS

DR. KENNETH DANIEL BLACKFAN, since 1923 professor of pediatrics at Harvard University, died on November 29 at the age of fifty-eight years.

WALTER MATHEW DUNAGAN, associate professor of theoretical and applied mechanics at the Iowa State

College, died on November 24 at the age of forty-seven years.

DR. ROBERT RANDOLPH JONES, JR., assistant professor of surgery at Duke University, was shot and killed on November 18 in the private clinic at Duke Hospital at Durham, N. C. It is reported in the press that Dr. Jones had performed a plastic operation on the assassin about six months ago, but that the operation had been unsatisfactory to the patient and he had brooded over this until he became obsessed with the delusion that he had been mistreated. Dr. Jones was fifty-three years old.

FRIENDS at the University of Edinburgh of Dr. Stefan Kopeć, professor of biology in the University of Warsaw, have received word of his death from Polish sources. *The Ameryka-Echo,* a Polish newspaper, published in Chicago, carried last summer an announcement that he had been killed by the Germans. According to this announcement, Professor Kopeć was arrested with a hundred and fifty other citizens, every tenth of whom was executed. These were said to be in reprisal for the unsolved murder of the director of a Polish theater who had accepted service for German propaganda.

SCIENTIFIC EVENTS

ATKINS INSTITUTION OF THE ARNOLD ARBORETUM

ACCORDING to the *Journal* of the Arnold Arboretum, in the planting expansion program of the Atkins Institution at Soledad, Cienfuegos, Cuba, a number of palms were moved into the palm section, and several hundred shrubs and trees were transplanted into the newly acquired areas. In the additional area transferred to the garden in February, 1939, by the Soledad Sugar Company, the last cane crop has been harvested, so that all the land is now available for planting and development. Naturally with a restricted and modest income, as the planted areas are increased, a higher percentage of the income has to be used for maintenance purposes, so that the expansion of the plantings must of necessity be slow. It has been necessary to extend the nursery area, and Dr. Mangelsdorf's tropical American corn varieties being grown at Soledad have required the preparation of land for this purpose. A new entrance to the gardens was made at the corner of the recent addition below Casa Catalina, thus making the approach more direct. During the year 340 packets of seeds and 750 living plants were received and 433 packets of seeds, 46 living plants and 53 lots of cuttings were distributed. Mr. Sturrock's book on tropical fruits for southern Florida and Cuba and their uses was published through the cooperation of the Arnold Arboretum in 1940, the income from sales being impounded for the use of the Atkins Institution. About forty individuals enjoyed the hospitality of Harvard House for varying periods of time, the most that have taken advantage of the facilities available in any one year since the institution was organized. These included fourteen representatives of Harvard University working on various botanical and zoological problems. Other educational institutions represented include Wilson College, the University of Colorado, the University of Ohio, Skidmore College, the University of Montreal, Colegio de la Salle and the University of Havana. Other institutions and organizations represented were the Fairchild Tropical Garden, the New York Botanical Garden, Montreal Botanical Garden, the Cleveland Museum of Natural History, the Ohio Division of Plant Industry, United Fruit Company and Cuban Agricultural Experiment Station. A group of four, under the leadership of Mr. and Mrs. Warren H. Corning, representing the Cleveland Museum of Natural History, made the Atkins Institution their headquarters for about a month while collecting natural history material for that institution. Among the Harvard staff members and students were Messrs. Gunckel, Salvin, Dahl, Howard, Hodge and Godfrey, who spent extended periods in the summer of 1940 working on various botanical problems, and Messrs. Dethier and Greenway, prosecuting zoological work. An extensive series of botanical specimens representing Cuban species was presented by José Carabia. The comprehensive collecting campaign initiated by Dahl, Howard, Godfrey and Hodge in the summer of 1940 will be continued during the summer of 1941, the objective being to secure the material on which a reasonably comprehensive flora of southern Santa Clara Province may be based.

SYMPOSIA ON EQUINE ENCEPHALOMYELITIS AND MOSQUITO CONTROL

THE twelfth annual conference of the California Mosquito Control Association will be held at the University of California at Berkeley, on December 15 and 16.

Speakers and their subjects will be:

I. *Opening Address,* President Earnest Campbell, superintendent, Contra Costa Mosquito Abatement District.

II. *Symposium on Equine Encephalomyelitis*

A. *Introduction,* Professor W. B. Herms, head of

the Division of Entomology and Parasitology of the University of California.

B. *The Relationship of Equine Encephalomyelitis and St. Louis Encephalitis to Man and Animals in California,* Beatrice Howitt, Hooper Foundation, University of California.

C. *Newer Developments in Knowledge of Insect Hosts and Vectors,* William C. Reeves, Division of Entomology and Parasitology, University of California.

D. *Host Animals of Virus Encephalitis,* Dr. W. McD. Hammon, Hooper Foundation, University of California.

Discussion by: Dr. W. T. Harrison, liaison officer, U. S. Public Health Service, 9th Corps Headquarters; Dr. Ellis D. Sox, coordinating officer, California State Department of Public Health.

III. *Symposium on Mosquito Control and National Defense*

A. *Introduction* by Dr. Bertram P. Brown, director, State Department of Public Health.

B. *Military Mosquito Control in World War I,* Dr. S. B. Freeborn, professor of entomology and assistant dean of the College of Agriculture, University of California at Berkeley.

C. *Federal Aid in Mosquito Control Work,* Dr. R. H. Creel, district director, U. S. Public Health Service.

D. *Mosquito Breeding and Control in Vicinity of Military Zones,* R. F. Peters, state mosquito control officer.

At the evening banquet Dr. A. C. Reed, Division of Preventive Medicine, University of California Medical School, will speak on "Problems Involved in Control of Mosquito Borne Diseases under Tropical Conditions."

The second day will include a "Review of Literature on Mosquitoes for 1940–41" and a laboratory demonstration on identification of California mosquitoes by William C. Reeves, Division of Entomology and Parasitology, University of California. "Review of Recent Changes in Legislation Affecting Mosquito Control Operations," by Harold F. Gray, engineer and executive officer, Alameda County Mosquito Abatement District. "The Effect of Priorities and National Defense on Mosquito Control Operations," by Fred Hayes, superintendent, Dr. Morris Mosquito Abatement District, Bakersfield. The last item on the program will be an operators symposium on problems of power spraying, larvicides, mosquito fish, breeding in sewer farms, controlled reflooding and rice field control.

Representatives from over twenty-five mosquito abatement districts and from health departments and universities in California ordinarily attend the conference. In addition, invitations are sent to state universities, health departments and individuals in all the western states.

AWARDS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

THE following awards were presented by the American Society of Mechanical Engineers at the annual dinner of the society on December 3:

Theodor von Kármán, director of the Guggenheim Laboratory of the California Institute of Technology, Pasadena, who is a consultant of the material division of the U. S. Army Air Corps, will receive the American Society of Chemical Engineers Medal for 1941. The citation is for "his brilliance as a teacher, his researches in elasticity and many fields of physics and mechanics, and his distinguished leadership in the fields of aerodynamics and aircraft design."

John C. Garand, of the Springfield Armory, Mass., will receive the Holley Medal, instituted in 1924 "to be bestowed for some great and unique act of genius of engineering nature, that has accomplished a great and timely public benefit." The citation is "for his invention and development of the semi-automatic rifle which bears his name and has been adopted by the United States Army, and is a distinct contribution to our National Defense."

The 1941 Worcester Reed Warner Medal, established to recognize outstanding contributions to permanent engineering literature, is awarded to Richard Vynne Southwell, professor of engineering science at the University of Oxford. The citation is "for his many distinguished services to engineering and science through papers and publications in many fields, including aeronautics, theory of structures, elasticity and hydrodynamics."

Roger Vernon Terry, assistant chief engineer of the Newport News Shipbuilding and Drydock Company, Newport News, Va., will receive the Melville Medal for his paper, "Development of the Automatic Adjustable-Blade-Type Propeller Turbine," presented at the 1940 annual meeting of the society.

Rollin Hosmer Norris, engineer in charge of the heat transfer section of the general engineering laboratory of the General Electric Company, Schenectady, is awarded the 1941 Pi Tau Sigma Award "for outstanding achievement in mechanical engineering, particularly in the heat transfer field." This award was established by the National Honorary Mechanical Engineering Fraternity to be presented for outstanding achievement within ten years after graduation from a mechanical engineering course in a recognized American college or university.

John T. Rettaliata, an engineer of the Allis-Chalmers Manufacturing Company, Milwaukee, will receive the 1941 Junior Award, presented for the best paper or thesis submitted by a junior member, for his paper, "The Combustion-Gas Turbine."

John J. Balun, a student engineer with the General Electric Company in Schenectady, N. Y., will receive the 1941 Charles T. Main Award for the best paper written by a student-member on the subject, "The Need and Pos-

sibilities of Participation by Engineers in Public Affairs."

G. Walker Gilmer, 3d, engineer with Pan American Airways-Africa, Ltd., on stress analysis and repair design on the aircraft ferried by the company to Africa under the defense program, will receive the 1940 Undergraduate Student Award of the society for his paper, "Center of Pressure Characteristics of a Marconix Yacht Sail."

THE TWENTIETH ANNIVERSARY OF THE PSYCHOLOGICAL CORPORATION

A LUNCHEON and a panel program to mark the twentieth anniversary of the Psychological Corporation and to honor its founder, James McKeen Cattell, was held in the Hotel Roosevelt, New York, on November 28. At the luncheon Professor Walter R. Miles, of Yale University, presided, and addresses were made by Professor Edward L. Thorndike, of Teachers College, Columbia University, and Dr. Paul S. Achilles, vice-president and managing director of the Psychological Corporation. The luncheon was attended by more than three hundred of those interested in psychology. Announcement was made of the establishment of grants in honor of Dr. Cattell to be made annually to graduate students to promote work in applied psychology.

Panel discussions, in which twenty-five psychologists took part, and their chairmen were as follows:

Public Opinion and Consumer Surveys, Dr. George H. Gallup, of the American Institute of Public Opinion.

Industrial Psychology and Personnel, Dr. Walter V. Bingham, chief psychologist, Personnel Procedures Section, the Adjutant General's Office.

Psychology in Guidance and Counseling, Dr. Walter R. Miles, professor of psychology, School of Medicine, Yale University.

SCIENTIFIC NOTES AND NEWS

PROFESSOR HARLOW SHAPLEY, director of the Harvard College Observatory, has been awarded the Pius XI Prize for Astronomy of the Pontifical Academy of Science amounting to approximately $2,500 at normal exchange. The announcement of the award was made by the president of the academy, the Rev. Agostino Gemelli, at the inauguration of the new academic year, which was attended by the Pope.

PROFESSOR FRED C. KOCH, Frank P. Hixon distinguished service professor emeritus at the University of Chicago, has been elected honorary foreign member of the National Academy of Medicine of Buenos Aires.

HARVARD UNIVERSITY has conferred the degree of doctor of laws on Dr. Percy R. Howe, Thomas Alexander Forsyth professor of dental science and director of the research laboratory of Forsyth Dental Infirmary in the Harvard Medical School.

IN honor of Dr. David D. Leib, who for twenty-five years has been professor of mathematics, registrar and director of admissions at Connecticut College, New London, the college hopes to raise $100,000 for a scholarship fund.

PROFESSOR EDWARD J. KEEGAN, chairman of the department of biology of St. John's University, Brooklyn, has been elected president of the New York Chapter of the Society of American Bacteriologists.

DR. KATHARINE ELIZABETH MCBRIDE, dean of Radcliffe College, Cambridge, Mass., A.B. and Ph.D. of Bryn Mawr College and formerly associate professor of education and philosophy there, has been elected president of the college, to succeed Dr. Marion Edwards Park, who has been president since 1922.

DR. CLARENCE H. BEECHER, professor of medicine at the University of Vermont College of Medicine, has been appointed dean to succeed Dr. Hardy A. Kemp, who has become dean of the College of Medicine of the Ohio State University.

DR. GEORGE W. MUHLEMAN, who retired recently from Hamline University, has become visiting professor of chemistry at Alma College, Michigan.

DR. WILLIAM T. CLARK, associate professor of hygiene and public health at the School of Medicine of the University of Buffalo, has been appointed professor and head of the department, to succeed the late Dr. Walter S. Goodale, who had held the position for sixteen years prior to his death on October 8.

DR. RAFAEL E. PONTIS, director of the Government Laboratory of Phytopathology at Mendoza, Argentina, has become a member of the division of plant pathology of the College of Agriculture of the University of California.

DR. MILO HELLMAN, professor of dentistry at Columbia University and research associate in physical anthropology at the American Museum of Natural History, New York, has retired from active practice and will devote his time to consultation and research.

DR. WILLY PRAGER, formerly acting director of the Institute of Applied Mechanics of the University of Göttingen and, after having been "requested" to leave Germany in 1933, professor of applied mechanics at the University of Istanbul, has been appointed professor of mechanics at Brown University.

DR. FRANCIS PERRIN, professor of theoretical physics at the Sorbonne, Paris, has been appointed visiting professor of chemistry at Columbia University. He will conduct graduate seminars in theoretical physical chemistry. Dr. Perrin is the son of Professor Jean Perrin, who was visiting professor at Columbia University in 1913.

DR. WILLARD C. RAPPLEYE has been elected president of the Josiah Macy Jr. Foundation, to succeed the late Dr. Ludwig Kast, who died last August. Dr. Rappleye is dean and professor of medical economics at the College of Physicians and Surgeons, Columbia University, and a director of the New York Post-Graduate Medical School and Hospital.

DR. CAROLINE B. ZACHRY, director of research of the Progressive Education Association and of the Institute for the Study of Personality Development, New York, has been nominated for the post of director of the Bureau of Child Guidance of the New York City school system. She will receive, it is said, a salary of $12,000.

WALTER R. G. BAKER, Chester H. Lang, David C. Prince, Elmer D. Spicer and Harry A. Winne have been elected vice-presidents of the General Electric Company, Schenectady, N. Y.

DR. B. H. WILLIER, Henry Walters professor of zoology and chairman of the department of biology at the Johns Hopkins University, has accepted the editorship of *The Quarterly Review of Biology*, beginning with Volume 17 (1942). The *Review* was founded by the late Raymond Pearl in 1926, and edited by him continuously until his death in 1940. In the interim the editorial work of the *Review* has been carried forward by Mrs. Pearl.

DR. ORLANDO PARK, Northwestern University, will succeed Dr. W. C. Allee as editor of the Section of General Animal Ecology of *Biological Abstracts*. The Section of Speciation will be conducted by Dr. Alfred Emerson, of the University of Chicago.

GORDON GORDON-TAYLOR, Surgeon Rear-Admiral to the British Royal Navy, has been visiting the United States. During the week of November 3 he attended the thirty-first Clinical Congress of the American College of Surgeons in Boston. During this session he received an honorary fellowship in the college and spoke concerning certain aspects of military and naval surgery. For the week from November 9 to 15 he was surgeon-in-chief *pro tempore* at the Peter Bent Brigham Hospital, Boston, and again spoke on military and naval surgery before the Harvard Medical Society.

IT is announced by Dr. Franz Boas, professor emeritus of anthropology at Columbia University, that a protest against the imprisonment by the Germans in France of five French scientific men, all members of the Academy of Sciences, has been sent to Marshal Petain signed by a group of workers in science and education. Copies of the letter were sent to Gaston Henry-Haye, the French Ambassador to Washington, and to Secretary of State Cordell Hull. Those imprisoned are Dr. Emile Borel, director of the Institut Henri Poincaré and Institut des Hautes Etudes, a former Minister of the Navy under Painlevé; Dr. Paul Langevin, formerly professor of physics at the Collège de France, president of the Solvay Council for Physics; Dr. Aimé Cotton, professor of physics; Charles Mauguin, professor of mineralogy and crystallography, and Dr. Louis Lapicque, professor of physiology at the Sorbonne, a member of the Academy of Medicine.

DR. HENRIK DAM, discoverer of vitamin K and associate professor at the Biological Institute of the University of Copenhagen, addressed the department of biological chemistry and the University of Cincinnati Chapter of Sigma Xi on "A Survey of the Present State of Knowledge on Vitamin K" on November 26.

PROFESSOR J. C. DRUMMOND, scientific adviser to the British Ministry of Food, is delivering a series of four lectures at the Royal Institution, London, on "Recent Advances in the Science of Nutrition and Their Significance in Wartime."

NOMINATIONS for membership in the American Society of Naturalists should be in the hands of the secretary, Dr. Alfred C. Kinsey, Indiana University, Bloomington, by December 10, if they are to be acted upon by the executive committee and the society at the forthcoming annual meetings at Dallas. All members of the society are entitled to make such nominations. The rules of the society provide that "the qualifications for membership should include a demonstration of continued research productiveness of high order in some branch of biological science, combined with a philosophical interest extending beyond a single research field."

THE autumn meeting of the American Society of Agricultural Engineers was held from December 1 to 3 at the Stevens Hotel, Chicago, under the presidency of Geo. W. Kable.

THE Soil Science Society of America held its annual meeting in Washington, D. C., from November 12 to 14, at which nearly a hundred scientific papers were presented. There was a symposium on "Calicium in the Soil," discussed from a physico-chemical point of view by Dr. Richard Bradfield, of Cornell University; from a biological point of view by Dr. W. H. Pierre, of the Iowa State College, and from the geographic point of view by Dr. Hans Jenny, of the

University of California. At the annual banquet Dr. Bushrod W. Allin, of the U. S. Department of Agriculture, outlined the vital rôle of soil investigators in agricultural planning, especially in the critical years to come, if production is to be adjusted to war needs and subsequent adjustments to peace time are to be made without waste and suffering. Officers were elected as follows: Dr. Horace J. Harper, professor of soils in Oklahoma State Agricultural and Mechanical College, became president for 1942, and Dr. Firman E. Bear, professor of soils at Rutgers University, was elected secretary. Dr. Charles E. Kellogg, chief of the Division of Soil Survey in the U. S. Department of Agriculture, is the retiring president. The next annual meeting is to be held in St. Louis in November, 1942.

AN academy conference at Dallas, Texas, has been scheduled to follow immediately the council session on Monday afternoon, December 29. The session will convene in Parlor E, Hotel Adolphus. The council session is set for 2:15, but if the usual practice is followed this session will be adjourned early in order to give the conference ample time for the reading of papers and discussion. A complimentary dinner will be held at 6:30 P.M. Two papers will be presented. The first, "A Progress Report on Research Grants," will be presented by Dr. E. C. Faust, of the New Orleans Academy. The second, entitled "The Development of a Collegiate Division of the Texas Academy of Science," will be presented by Dr. J. C. Godbey.

A CONFERENCE on "The Ultracentrifuge" was held on November 14 and 15, under the auspices of the Section of Physics and Chemistry of the New York Academy of Sciences. Papers were presented by J. W. Beams, University of Virginia; J. W. Williams, University of Wisconsin; W. J. Archibald, National Research Council, Canada; Alexandre Rothen and Duncan A. MacInnes, both of the Rockefeller Institute, the latter acting as conference chairman.

THE eighth annual congress of the American Association for the Advancement of Oral Diagnosis was held at the New York Academy of Medicine on November 13 and 14. Speakers at the meeting included Dr. J. L. T. Appleton, Jr., dean of the Dental School of the University of Pennsylvania, and Dr. Kurt H. Thoma, head of the new school of Oral Medicine at Harvard University.

A SYMPOSIUM on "Recent Advances in the Chemistry of the Nonmetals" will be held in Columbus, Ohio, on December 29, 30 and 31, under the sponsorship of the Division of Physical and Inorganic Chemistry of the American Chemical Society.

THE University of Michigan will be host to chemists who attend the ninth National Organic Chemistry Symposium from December 29 to 31. Dr. Moses Gomberg, University of Michigan, and Dr. William Lloyd Evans, of the Ohio State University, president of the American Chemical Society, will open the symposium, which will be addressed by Homer Adkins, W. E. Bachmann, Leslie G. S. Booker, Nathan L. Drake, Karl Folkers, C. R. Hauser, Morris S. Kharasch, S. M. McElvain, C. S. Marvel, Ralph L. Shriner, Roger J. Williams and Frank C. Whitmore. Inquiries should be addressed to Dr. Arthur C. Cope, Department of Chemistry, Columbia University, New York, N. Y.

DR. ERIC S. PROSKAUER, of Interscience Publishers, Inc., calls attention to the misspelling of names of German physicists in an article printed under "Special Correspondence" in the issue of SCIENCE for November 21. This correspondence, which was entitled "Physics in Pre-Nazi Germany," should have been entitled "Physics in Nazi Germany." It was sent by a Russian correspondent through *Tass*. The editor of SCIENCE, in reading the manuscript, was more concerned as to whether it should be printed than with the spelling of names, in regard to which the proofreaders of SCIENCE are usually very accurate. As a matter of fact, the editor was absent from his office attending the meeting of the American Philosophical Society in Philadelphia when the proof was received. Such names as Klausius for Clausius appear to be due to a transcription of German names into Russian and retranscription into English. The names are obvious, but the errors in spelling are regrettable.

DISCUSSION

NICOTIANA RUSTICA IN NEW MEXICO

PROFESSOR LESLIE A. WHITE reports[1] finding *Nicotiana rustica* cultivated in 1934 by the Tamaya Pueblo Indians near Bernalillo, New Mexico, and states:

> This discovery is of interest for two reasons: (1) There is very little evidence indeed to indicate that tobacco of any kind has ever been cultivated by the Pueblo Indians of the Southwest; and (2) it is surprising to find this particular species of Nicotiana in this region. . . .
>
> The presence of this species under cultivation at Tamaya to-day remains to be explained. It may have been introduced within the past 50 years or so from some eastern Indian reservation, to be sure. But the possibility that it may be a relic of the original diffusion from Mexico can not be entirely dismissed at this time.

[1] Leslie A. White, SCIENCE, Vol. 94, p. 64.

The suggestion is offered that the presence of *Nicotiana rustica* in the vicinity of Bernalillo in 1934 and 1936 as reported by Professor White may have been due to its rather recent introduction by the white man. In 1925 a commercial development was undertaken for the production of *Nicotiana rustica* for nicotine in the upper Rio Grande Valley. In 1927 several hundred growers were reported engaged in the production of the species on plots ranging from fractions of an acre to 8 or 10 acres. Most of the growers were located north of Albuquerque, and more than 200 acres were reported grown in 1927. This project was developed and managed by Mr. R. G. Mewborne, of the Consumers Tobacco Company of Albuquerque, New Mexico, and continued through 1929.[2]

Between 1926 and 1929 the writer was also interested in the experimental production of nicotine in the Rio Grande Valley and had plots grown near Albuquerque, Las Lunas and Las Cruces, New Mexico. Several varieties of *Nicotiana rustica* were grown, although brazilia was the one used in the general commercial production.

During the period of 1925 to 1929 rustica plants and, no doubt, seeds as well, were easily available in the upper Rio Grande Valley, and it is suggested that the presence of the rustica plants near Bernalillo might well be traced to the wide-spread development which was attempted in that area between 1925 and 1929.

E. G. BEINHART

U. S. DEPARTMENT OF AGRICULTURE

A NOTE ON THE DETERMINATION OF THIAMINE BY THE YEAST FERMENTATION METHOD

IN a recent issue of SCIENCE[1] a paper on thiamine determination contained the following paragraph:

> Bunzell's difficulties recall the experience of Smythe, who, observing a remarkable stimulation of fermentation due to an extract of bull testicle, finally isolated ammonium chloride as the active factor. Smythe made the additional mistake of obtaining his yeast from the small cakes sold in grocery stores. Such yeast is too rich in thiamin to show any stimulation of fermentation when thiamin is added to the medium.

This curious paragraph contains both misstatements of fact and false implications so a correction is considered necessary. My paper[2] was not concerned with the determination of thiamin. It was concerned with finding out why the extracts in question stimulated fermentation when thiamin did not stimulate. Consequently, it was neither a mistake nor an additional mistake to use a yeast rich in thiamin. It clearly would have been a mistake to use a yeast in which thiamin was not present in excess.

Although ammonium chloride was isolated and shown to stimulate fermentation under certain conditions by as much as 100 per cent., the activity of the extracts was not found to be due solely or even chiefly to the ammonium chloride contained in them. From the chemical behavior of the extracts it was suggested that the activity was due to amino acid amides—free and combined. In accord with this suggestion glutamine and asparagine were shown actively to stimulate fermentation. d-Arginine also was found to be an active stimulator. As stated in the paper[2] an accelerating effect of ammonium salts on fermentation had been established as long ago as 1926,[3] but an accelerating effect (as distinct from a growth effect) for the other compounds mentioned had not been established as far as I am aware.

The above results were presented at a symposium held at Gibson Island in August, 1938,[4] and appeared in the February, 1939, issue of *Enzymologia*.[2] It is interesting to note that the first published account of the thiamin fermentation method to properly define the principle and limitations of the analysis was sent to press in May, 1939.[5] The fact that asparagine and arginine (along with some other less active amino acid compounds) stimulate fermentation was published by the same authors as new information in September, 1939,[6] and is cited by them in their recent paper as showing that various amino acids, etc., have an effect equivalent to ammonium ions.

C. V. SMYTHE

UNIVERSITY OF PITTSBURGH

EXCEPTIONAL BURIAL IN CALIFORNIA

DURING excavations carried on by the Santa Barbara Museum of Natural History, a unique burial was uncovered on Mescalitan Island, an old Indian site, near Santa Barbara, California. This find is outstanding among burials of the west coast.

The skeleton of a small adult, age 30–35, lay in the conventional face-down flexed position of the Canaliño (Chumash), but upon the highly inlaid scapula of a whale. The scapula had served as a slab, or a coffin without top or sides, and measured 46½ inches transversely and 30 inches proximo-distally. The spine had been planed off with stone tools, forming a perfectly flat surface upon which the skeleton lay. Around the superior border a narrow groove was cut and in this,

[1] A. S. Schultz, L. Atkin and C. N. Frey, SCIENCE, 94: 212, 1941.

[2] C. V. Smythe, *Enzymologia*, 6: 9, 1939.

[2] R. G. Mewborne, "Tobacco as a New Industry for New Mexico," New Mexico State Planning Board, Santa Fe, 1936.

[3] H. Zeller, *Biochem. Zeits.*, 175: 135, 1926.

[4] SCIENCE, 88: 9, 1938.

[5] L. Atkin, A. S. Schultz and C. N. Frey, *Jour. Biol. Chem.*, 129: 471, 1939.

[6] A. S. Schultz, L. Atkin and C. N. Frey, *Cereal Chem.*, 16: 648, 1939.

inlaid with asphalt, is a row of *Olivella* shell disks of the type commonly worn as beads. These shells are placed about five to the inch, with a total of 305 shells, part of which were covered with the skeleton, there being 170 beads visible.

Two abalone shell disks about three inches in diameter were on each side of the skeleton, countersunk and secured with asphalt, together with calluses of the limpet *Megathura*. The abalone disks are surrounded by a row of *Olivella* disks, as are some of the limpets. The design is not symmetrical, although at casual glance it appears so.

The skull lay face down, hands folded under the skeleton. Across the neck was a string of large steatite tubular beads, each bead carved or inlaid and about three inches long, mixed with strings of *Olivella* shell disk beads. A short strand was upon each knee and another long strand lay along the spine.

Beside the skull, on the left, was a small stone bowl lying on its side—the mouth of the bowl pressed against the side of the skull. This bowl is about four inches across by two and three-quarters deep.

Beyond the skull, many of the *Olivella* shell disk beads were found, apparently having been thrown into the grave by the handful. Fragments of a turtle shell rattle were also recovered.

This burial, which was taken out intact, is being displayed in the Santa Barbara Museum of Natural History as an exhibition just as it was uncovered, complete with a reproduction of the grave from which it came, and with painted background of the location.

The cemetery from which this specimen was secured represents the latter part of the earliest phase of the Canaliño culture of this area. A complete report of the excavation on Mescalitan Island is in preparation.

PHIL C. ORR

SANTA BARBARA MUSEUM OF NATURAL HISTORY

HIGGINS VERSUS HIGBEE

IN SCIENCE of July 26, 1940, p. 80, a short notice was published by Dr. Edna Higbee, of the University of Pittsburgh, on the results of injection of colchicine into hen's eggs. At the Philadelphia meeting of the American Society of Zoologists, Section of Endocrinology, December 30, 1940, Dr. Higbee (introduced by R. T. Hance) reported on her work with colchicine. Philadelphia newspapers and *The New York Times* of the following day selected her paper for their report on the meetings. Science News Service also included her paper in its report to the newspapers of the country. Unfortunately, an error slipped in, that changed Dr. Higbee's name to Higgins. And this error was perpetuated: in *Science News Letter* of January 25, it is Higgins, and so it is in the *Science News Supplement* to SCIENCE of February 14.

E. ALFRED WOLF

UNIVERSITY OF PITTSBURGH

QUOTATIONS

GERMAN PERSECUTIONS IN POLAND

WE have received from the Association of Polish Professors and Lecturers in Great Britain (Polish Research Centre, 32 Chesham Place, London, S.W.1) a letter protesting against the second series of persecutions by the Germans of Polish men of science and others since the war began. The fury of the first German attack on Polish science and culture was raging in November, 1939, when 180 professors and assistants of the oldest Polish university, that of Cracow, were deported "as criminals" to the concentration camp at Oranienburg. Now we are witnessing the second German attack on Polish science, carried out in the newly occupied territories and aiming at completing the destruction. On occupying Lwow the Germans executed Professor C. Bartel, professor of mathematics in the Lwow Technical College (see *Nature* of October 4, p. 402); they also arrested sixty other professors, among them a number of elderly men. The German persecutions are an integral part of the methodical campaign aiming at the total destruction of Polish culture. All the Polish universities, technical and agricultural colleges, commercial academies, all research institutes, all scientific societies, including the Polish Academy of Sciences, have been closed by the Germans. The same fate has befallen all secondary schools. The scientific apparatus and the equipment of laboratories have been transported to the Reich. The Polish museums were and still are being looted. Publication of books and periodicals as well as of independent newspapers has been suspended. Monuments which showed the artistic culture of the nation have been pulled down and destroyed.

All the professors of the University of Poznan have been expelled, deprived of all their personal possessions and left starving. Some of them, headed by Professor Bronislaw Dembinski, honorary professor of history, have died as a result of the dreadful conditions of life to which they were exposed. Eighteen professors of the University of Cracow, among them the most prominent representatives of Polish science, have died as a result of tortures suffered in the concentration camp of Oranienburg. The professors of the Catholic University of Lublin were kept in prison for some months and some of them are still in con-

centration camps. Recently a number of Warsaw professors perished as victims of undeserved persecution. "To this black record of German persecutions a new page has been added—the persecutions of Lwow. Executions and concentration camps for Polish men of science—that is what the German 'crusade in the defence of civilization' has brought with it." In view of these new German crimes which bear full witness to a total degeneration of Hitlerite Germany, we feel sure that men of science in all free countries will wish to join in this solemn protest by Polish savants in Great Britain.—*Nature.*

SCIENTIFIC BOOKS

THE ELECTRIC SPARK

The Mechanism of the Electric Spark. By LEONARD B. LOEB and JOHN M. MEEK. xiii + 188 pp. 43 figures. Stanford University Press. $3.50.

THE book is divided into three chapters, dealing respectively with the Townsend theory of the spark discharge, the streamer theory and the calculation of breakdowns in air. The first chapter develops the background necessary to a complete understanding of the problem, the second describes the point of view which the authors have been especially instrumental in developing, and the final section may be regarded as a discussion of certain practical applications.

The authors begin with a critique of the Townsend theory of the progress of an electrical discharge between two surfaces, and examine the regions of validity of this theory. They review the pertinent considerations and show at what points the observed facts depart from simple theory. They conclude that the mechanism envisioned by Townsend, which is known to be quite successful in explaining phenomena at low pressures and small distances, as for example in certain particular cases in Geiger counter action, do not apply in air at high pressures and big gap-lengths. Time-lags are discussed. The amount and nature of the departures of observation from theory suggests criteria to which a more comprehensive picture of the mechanism must conform.

In the next section, the authors develop the picture of the formation of streamers in a discharge. They point out the sources of error in past experiments, such as lack of stability control of potential sources, inaccuracies in voltage-measurement and of gas-purities. The properties of streamers are explored, as are the corollary effects due to overvoltage, branching and time-lags. The ion densities necessary for streamer propagation are computed and photo-effects are discussed. Finally the full development of a lightning stroke is described, and it is shown how the various considerations developed will explain the observed phenomena.

The final chapter deals with the applications of the theory to the actual calculation of breakdowns in gaps. Many examples are given, and the comparison of theory and observation is presented. The effect of pertinent factors such as air-density is discussed. The case of the breakdown in coaxial cylinders is considered at some length, this case being of practical importance in electrical power transmission problems; and finally, corona discharge is briefly considered.

On the whole the book contains a useful summary and digest of discharge theory, and should be of especial value to those working with the various aspects of spark discharges. Possibly owing to the incidence of the present emergency on all scientific work, the book shows some signs of haste in preparation, as a number of amusing statements have appeared which the authors would undoubtedly have altered had time been available. For example, the high speed ions are cited on page 39 as traveling at the incredible speed of 1.3×10^{-8} cms/sec; a sentence on page 56 ends with a reference to ". . . positive ions of a questionable sort," and the name of the firm by which the junior author was employed was spelled in the title page as the "Metropolitan Vicars Company." On the other hand, there is no doubt that the authors have done a good piece of work, and give a useful presentation of a subject on which they may be considered authorities.

SERGE A. KORFF

BARTOL RESEARCH FOUNDATION,
SWARTHMORE, PA.

METEOROLOGY

Dynamic Meteorology. By BERNHARD HAURWITZ. 365 pp. New York: McGraw-Hill. 1941. $4.00.

THIS book appears at an opportune moment. In recent years the science of meteorology has suddenly moved into the limelight from a state of comparative obscurity. The demands of civilian and military aviation and of a vastly expanded maritime activity have led ever increasing public circles to a realization of the significance of accurate weather forecasts and of the influence of the atmosphere upon innumerable activities of man.

The book gives an account of the analytical tools used by the meteorologist. Apart from offering to the professional a number of methods and formulae presented for the first time in a text-book, it should be of value to anybody who in the course of his work comes in contact with phenomena in the atmosphere. Although the presentation is essentially mathematical,

the formulae are always reduced to their simplest form and are derived in the clearest, most direct and easily understandable manner. Cross-references and similar complexities that mar most scientific text-books are here reduced to an absolute minimum. The book does not presuppose any particular knowledge of meteorology, but the non-meteorological reader will do well to use the book parallel with one of the numerous non-mathematical accounts of meteorology in order to keep in sight the practical significance of the methods discussed. Otherwise the student will not need more than a general knowledge of college physics and of calculus. Numerous footnotes throughout the book contain carefully selected references to original papers in dynamic meteorology and offer a valuable guide to the reader interested in ampler study in this field.

The first four chapters deal with the application of thermodynamics to the atmosphere, the second law of thermodynamics as far as needed being derived in the book itself. The fifth chapter treats briefly of the effects of solar and terrestrial radiation upon the air. The sixth to ninth chapters deal with the application of the hydrodynamic equations to the simplest cases of atmospheric motions, especially stationary flow. The fundamental equations are again derived in the book itself in a simple manner. The tenth and eleventh chapters contain an account of the theory of turbulence as applied to meteorology; here the simplicity of presentation without loss of comprehensiveness is particularly gratifying. The twelfth to fifteenth chapters deal with a variety of topics, such as the energy of atmospheric motions, the general circulation of the atmosphere, the perturbation theory of atmospheric motions and finally we get a glimpse of the ideas underlying the dynamical theory of fronts and cyclones where there is still much room for controversy and further research. The book brings the student to the threshold of all the important current problems in modern meteorology.

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SPECIAL ARTICLES

THE EFFECT OF INCREASED PANTOTHENIC ACID IN THE EGG ON THE DEVELOPMENT OF THE CHICK EMBRYO[1]

MODERATE variations in the intake of the "B vitamins" appear to be without effect on free-living animals. The ingestion of two or more times the daily requirement by an animal not suffering from a deficiency has not been observed to be associated with any special changes of a physiological nature.

Few if any attempts have been made to investigate the effects of a varied level of these vitamins during embryological development, even though the embryo with its special type of metabolism might be expected to respond in a different manner than has been the experience with post-embryological animals.

In the present investigation the pantothenic acid available to the chick embryo was increased in two ways, by direct injection into the egg before incubation and by supplementing the diet of a flock of hens with three times the daily requirement of this vitamin. For injection 100–150 micrograms or about 10 to 15 per cent. of the total pantothenic acid normally present in the egg was dissolved in sterile egg white and injected in this form into the experimental eggs. The control eggs received the same quantity of pure egg white.

The eggs from the hens on the supplemented diet were incubated at different periods after the special diet had been initiated. In this manner eggs can be obtained with varying levels of pantothenic acid up to more than twice the normal concentration.[2] The hens from which the eggs were taken consisted of pure-blooded white Leghorns whose regular diet was well balanced and apparently adequate in all respects.

After 12 days' incubation the control and experi-

TABLE 1

THE EFFECT OF RAISING THE LEVEL OF PANTOTHENIC ACID IN THE EGG 10 TO 20 PER CENT. BY INJECTION

Experiment	Number of embryos	Viability control = 100	Hemoglobin control = 100	Relative brain weight control = 100	Relative heart weight control = 100
Control	42				
Pantothenic acid	42		108	107	93
THE EFFECT OF RAISING THE PANTOTHENIC ACID LEVEL OF EGGS BY PLACING HENS ON SUPPLEMENTED DIET					
Group 1—Control	13				
Group 1—Pantothenic acid*	30	115	116	106	100
Group 2—Control	13				
Group 2—Pantothenic acid	31	123	113	103	82
Group 3—Control	8				
Group 3—Pantothenic acid	24	130	108	96	83
1 to 3 days after discontinuing supplementary diet					
Group 4—Control	13				
Group 4—Pantothenic acid	27	109	119	90	85

* Group 1, eggs collected 4–6 days after initiating supplemented diet; group 2, 7–9 days; group 3, 11–14 days; group 4, 1–3 days after discontinuing supplemented diet.

[1] This investigation was supported by a grant from the Clayton Foundation.

[2] Snell, Aline, Couch and Pearson, *Jour. Nutrition*, 21: 201, 1941.

TABLE 2

THE EFFECT OF AN INCREASE OF PANTOTHENIC ACID IN THE EGG ON THE VITAMIN LEVEL OF THE LIVER, BRAIN AND HEART OF THE DAY-OLD CHICK

Vitamin	Vitamin level of eggs raised by supplementing diet of hens								
	Exper. liver γ/gm.*	Control liver γ/gm.	Exper. liver when control = 100	Exper. brain γ/gm.	Control brain γ/gm.	Exper. brain when control = 100	Exper. heart γ/gm.	Control heart γ/gm.	Exper. heart when control = 100
Pantothenic acid ...	98.0	99.0	99.0	270.0	250.0	108.0	224.0	186.0	120
Inositol	2600.0	2200.0	118.0	8800.0	13000.0	67.5	2700.0	2400.0	113
Nicotinic acid	260.0	410.0	63.5	200.0	230.0	87.0	262.0	246.0	107
Riboflavin	40.0	51.0	78.5	6.3	6.9	91.2	32.0	34.0	94
"Folic acid"	99.0	180.0	55.0	5.0	7.5	66.7	6.6	6.0	110
Thiamin	5.2	5.7	91.0	2.5	5.3	47.0	2.8	2.9	97
Pyridoxin	1.4	2.4	59.2	2.5	1.3	192.0	.98	.77	127
Biotin	.50	.39	128.0	.028	.038	74.0	.078	.075	104

* γ/gram dry weight.

mental embryos were examined for blood hemoglobin concentration and relative size of the heart and brain. Data on the effect of the varied pantothenic acid level in the egg on hatchability were also obtained.

Six control and six experimental eggs from the group with the highest level of pantothenic acid were allowed to hatch and the liver, heart and brain of these chicks were assayed for several of the "B vitamins."

It is evident from Table 1 that there was a definite tendency for increased pantothenic acid in the egg to be associated with an increased hemoglobin concentration of the blood in the 12-day chick embryo. The effect on the relative brain and heart size depended upon the concentration of pantothenic acid present in the egg. A comparatively low concentration tended to be associated with a larger than normal brain, while both heart and brain were depressed in relative size in the embryos from the eggs with higher levels of pantothenic acid.

Embryo survival was better in every group of the eggs from the hens on the supplemented diet, indicating that a relatively high level of pantothenic acid in the egg is associated with improved hatchability.

The results given in Table 2 show that concomitant with the changes in brain and heart size there was also some shift in the balance and level of the eight vitamins in the tissues for which assays were made. This was especially true for the liver and the brain.

Work in progress indicates that some other members of the "B complex" modify the chick development when their level in the egg is raised to a moderate degree—which tends to confirm the results reported here for pantothenic acid.

It appears that during early embryological development, the chick embryo is highly responsive to a vitamin imbalance created by a moderate increase in the level of one of these food elements. Apparently the embryo is dependent on this vitamin balance even for such fundamental characteristics as blood hemoglobin concentration and brain and heart size.

We wish to express our grateful appreciation to Dr. R. J. Williams for his interest and encouragement in this research.

ALFRED TAYLOR
JUANITA THACKER
DOROTHY PENNINGTON

THE UNIVERSITY OF TEXAS

THE PHENOMENON OF THIXOTROPY IN HEMOPHILIC AND HEPARINIZED BLOOD[1]

IN 1923 Szegvari and Schalek[2] observed a property of gels with hydrous ferric oxide for which the term "thixotropy" was suggested by Péterfi in 1927.[3] Ever since it has often been observed that an apparently solidified gel or a very viscous colloid can be liquefied by shaking or other mechanical agitation and upon standing again becomes a gel. This process, in which the time factor becomes apparent, can be repeated and is dependent upon temperature. Previous to this observation in Freundlich's laboratory[2, 4] Chambers[5] had observed in 1921 that frequently protoplasm becomes fluid by stirring with the micro-manipulator needle, and after some time becomes gelatinous again when permitted to stand. It is of great interest and it should be recognized that the phenomenon of thixotropy was described for the first time in 1910 by Howell[6] in studies of the conversion of fibrinogen to fibrin by the addition of thrombin in various amounts. He referred to observations on a similar process in horse's plasma at an earlier time.[7] Minot and Lee[8] observed this

[1] Aided by a grant from the Dazian Foundation for Medical Research.

[2] A. Szegvari and E. Schalek, *Kolloid-Z.*, 32: 318, 1923; 33: 326, 1923.

[3] T. Péterfi, *Arch. f. Entwcklngsmech. d. Organ.*, 112: 660, 1927.

[4] H. Freundlich, *Kolloid-Z.*, 46: 289, 1928.

[5] R. Chambers, *Proc. Soc. Exp. Biol. and Med.*, 19: 87, 1921.

[6] W. H. Howell, *Am. Jour. Physiol.*, 26: 453, 1910.

phenomenon with blood coagula of hemophiliacs and called it "reclotting phenomenon." There is only occasional reference made to it in the literature on hemophilia and it has not been especially studied by any one.[9]

Minot and Lee, who never wrote further on this phenomenon, at least in the direct sense,[10] described thixotropy as follows: "If, after the hemophilic blood had apparently clotted firmly, the clot was loosened and removed from the fluid, the fluid would clot and would do so sometimes almost at once, often in three to five minutes and sometimes not for ten to thirty minutes or more. Again on separating the clot, but not removing it from the serum, this reclotting phenomenon occurred and might be repeated from three to six times. The reclotting would occur no matter whether the clot was loosened a few minutes or a few hours after it had appeared solid. If one waited hours rather than minutes after the clot had formed, one usually obtained the reclotting phenomenon fewer times." Since we[11] succeeded in producing experimentally a hemophilia-like condition in mice by injections of excessive doses of purified heparin, it was of interest to investigate if thixotropy would occur with coagula of blood heparinized *in vitro* and *in vivo*.

Blood was obtained from the antecubital vein of humans and the femoral and jugular veins and the femoral artery of dogs. Heparin of the Connaught Laboratories, University of Toronto, 110 units per milligram, was used in doses between 0.1 and 2.0 units in physiological saline. All experiments were done at room temperature. 0.02 cc of the heparin solutions were placed into clean test-tubes and 1 cc of blood was added to each tube. In intervals between 30 seconds and 1 hour after the clot had formed it was disturbed by shaking or stirring and the time was measured until the clot formed again. For controls, blood was added to 0.02 cc of physiological saline. Blood coagula were tested from 44 dogs and 6 humans. Thixotropy always occurred with blood which was mixed with heparin, whereas the phenomenon never occurred in the controls. In samples containing 0.4 to 0.5 units, thixotropy occurred two to four times within 1 hour following the coagulation time of the blood. The phenomenon, if reproducible, occurred after a longer interval of time than previous to it after the second successive reclotting. Blood from 12 dogs drawn 26 to 50 minutes following intravenous injection of 200 units of heparin per kilogram weight was tested for its thixotropic property. In all cases thixotropy occurred two to seven times.

The observations of Minot and Lee could be repeatedly and fully verified with blood coagula of two hemophiliacs. The phenomenon was likewise observed with hemophilic plasma which was prepared after centrifuging hemophilic blood at 3,000 r.p.m. for 15 minutes. After the plasma had coagulated, the gel was loosened by a glass rod upon which it retracted rather suddenly and the formed fibrin was removed. From one or several minutes the gel formed again and the process of thixotropy could be repeated; in one case for five, and in the other for eight times. Plasma which was obtained from three of the heparinized dogs showed similar results, although it occurred only for two to three times.

The occurrence and frequency of thixotropy with heparinized blood or plasma is dependent upon the amount of heparin, the coagulation time and the length of time following the coagulation time and the reclotting, after which the gel is liquefied by mechanical agitation. The results indicate that the fibrinogen is progressively but slowly, at times over a period of hours, converted into fibrin in both the heparinized and the hemophilic conditions. This process may occur as long as there is either thrombin forming or until the amount of fibrinogen is exhausted due to its conversion. Studies of the mechanism involved in the production of thixotropy with blood coagula are being done. We are also determining whether the same mechanism is responsible for the phenomenon with both the hemophilic and heparinized coagula.

"Thixotropy" may be considered as a general term describing a physical system going for several times from semisolid to liquid state on mechanical agitation. It must be taken for certain that protoplasm with definite fibrillar elements actually exists according to Jordan.[12] That these protoplasmatic structures may be similar to the fibrin needle network of plasma gels is suggested at this time; however, the degree of similarity can only be taken into account by future work. Since a more exact classification of thixotropic phenomena does not exist at present the use of this term seems to be justified. The inclusion of the "reclotting phenomenon" with miscellaneous thixotropic systems should stimulate interest and ultimately lead to a better understanding of the thixotropy in blood plasma.

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[7] Professor Howell states in a personal communication that this work was done as early as 1892.

[8] G. R. Minot and R. I. Lee, *Archiv. Int. Med.*, 18: 474, 1916.

[9] W. H. Howell, personal communication, 1941.

[10] G. R. Minot, personal communication, 1941.

[11] A. L. Copley and J. J. Lalich, *Am. Jour. Physiol.*, in press.

[12] H. J. Jordan in "First Report on Viscosity and Plasticity," Amsterdam and New York, Nordemann Publishing Company, 1939.

THE EFFECT OF PYRIDOXINE ON THE URINARY EXCRETION OF A NEW FLUORESCENT SUBSTANCE[1]

RECENT reports[2, 3] have indicated that there are two fluorescent substances in the urines of normal individuals that are related to the level of nutrition of nicotinic acid. These have been named F_1 and F_2. The latter is absent in the urines of pellagrins, but readily appears after adequate nicotinic acid therapy. While investigating the possible correlation of this phenomena with the anti-pellagra and anti-black-tongue activities of nicotinic acid and related pyridine derivatives, the present authors observed a marked increase of fluorescence in the F_1 fraction following the ingestion of pyridoxine hydrochloride by normal and pellagrous patients. A dose of 100 mg of this vitamin is followed by a four- to ten-fold increase of a bluish-purple fluorescence during the first four-hour period as compared to the preceding control period. The average values of fluorescence in Najjar-Wood units for the control and test periods are 4 and 32, respectively. The urinary substance responsible for the increased fluorescence resembles F_1 in its adsorption on permutit ("Decalso"), elution with 25 per cent. potassium chloride solution and extraction from the eluate with isobutanol, but differs, however, from F_1 in that it is extracted from only the untreated eluate. *In vitro* experiments with pyridoxine either alone or incubated for four hours with urine at pH 5.0 failed to demonstrate the presence of the unknown substance. We believe, therefore, that this unknown urinary constituent is a new entity and perhaps of significance in the intermediary metabolism of pyridoxine. Until its relationship to F_1 and F_2 is known, we hesitate to propose a name for its description. The details of studies, now in progress, on its physical and chemical nature will be reported elsewhere.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A NEW TECHNIC FOR STAINING VAGINAL SMEARS: III, A SINGLE DIFFERENTIAL STAIN

Two previous communications to this journal[1, 2] have described modifications of the Masson trichrome stain, adapting it to the staining of vaginal smears. Among the advantages of this technic for the interpretation of the vaginal smear are its specificity for the cornified elements and the addition of a sequence of color changes to the cytological alterations which follow the endogenous elaboration, or the administration, of the reproductive hormones. Although this staining method is simple and rapid, the number of solutions required renders it somewhat cumbersome for general clinical use. A single differential stain would be more likely to encourage the wider use of the vaginal smear as a diagnostic index and as a guide for the therapeutic use of the reproductive hormones.

The purpose of this note is to describe a single differential staining solution, based on the technic previously developed and retaining its most useful features. In it are incorporated all the components of the original staining method with the exception of hematoxylin. It provides a sharp differentiation between cornified and non-cornified elements. The former stain a brilliant orange-red; the latter take on a green stain which is deeper in the younger cells, and paler in those more advanced. The staining is delicate and reveals cytoplasmic and nuclear details very clearly. Other constituents, such as leucocytes, erythrocytes, bacteria and spermatozoa, are satisfactorily differentiated.

This composition of the Single Differential Stain (S3) is as follows:

ethyl alcohol (50 per cent.)	100 cc
Biebrich Scarlet (water sol.)	0.5 gms
Orange G	0.25 "
Fast Green FCF	0.075 "
phosphotungstic acid c.p.	0.5 "
phosphomolybdic acid c.p.	0.5 "
glacial acetic acid	1.0 cc

All the dyes are domestic and can be obtained from the National Aniline and Chemical Company. The solution should not be used until all the ingredients have dissolved completely.

The vaginal smears are prepared and stained as follows:

1. Aspirate the vaginal secretion by means of a dry pipette with rubber bulb attached, and expel onto a glass slide.
2. Fix, while wet, in equal parts of ether and 95 per cent. alcohol. Fixation for 1 or 2 minutes is adequate.
3. Stain for approximately 1 minute in Solution S3.
4. Carry through 70 per cent., 95 per cent. and absolute

[1] Acknowledgement is made of aid from the John and Mary Markle Foundation.

[2] V. A. Najjar and R. W. Wood, *Proc. Soc. Exp. Biol. and Med.*, 44: 386, 1940.

[3] V. A. Najjar and L. E. Holt, SCIENCE, 93: 20, 1941.

[1] SCIENCE, 91: 321, 1940.

[2] SCIENCE, 91: 579, 1940.

alcohol, dipping slide 10 times in each solution.
5. Clear in xylol and mount in damar.

In preparing the smear, it is important not to allow the secretion to dry before fixation, as drying alters the morphology and the staining properties of the cells. Very thick smears are also undesirable, since it is difficult to remove the excess stain from the thick areas except by prolonged washing in the alcohols. A thick secretion should be spread out thinly with the edge of the pipette, taking care to avoid drying in so doing. Most reliance can be placed in the histological picture in the thinner areas.

When single slides are stained, it is most economical and convenient to deliver the stain from a dropping bottle. If the portion of the slide containing the smear is marked off with a china-marking pencil, one or two drops of stain generally suffice. It is economical to drain the slide thoroughly and wipe off the back with a cloth or paper towel after each solution, thereby prolonging the dehydrating properties of the alcoholic solutions. The absolute alcohol can be eliminated, by blotting the slide thoroughly after rinsing in 95 per cent. alcohol, and then going directly to xylol. All solutions should be well stoppered when not in use. The use of coverslips can be avoided by using isobutyl merthacrylate polymer P–5 (du Pont de Nemours and Co. Ammonia Dept., Wilmington, Del.) instead of damar. This is dissolved in xylol to yield a solution of proper consistency for mounting. After the slide is cleared in xylol, a few drops of the solution are placed on the slide to form a protective film over the smear. The slide can be examined at once, and then allowed to dry in air before filing.

While most investigators may prefer to use the complete trichrome stain previously described for research purposes, the present technic should fulfil most of the clinical requirements for a rapid simple differential stain for vaginal smears.

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A DEVICE FOR THE PREPARATION OF HYDROSULFITE SOLUTIONS FOR GAS ANALYSIS

A DISADVANTAGE in the use of sodium hydrosulfite solutions for the rapid absorption of oxygen in gas analysis, as suggested by Van Slyke and co-workers,[1] is the need for frequent renewals of the solution. This drawback could be partially overcome if a method were used by which a considerable proportion of the hydrosulfite is not oxidized by the air during the preparation of the solution. This may be accomplished by a simple device which has been used in this laboratory for several years.

This consists of a glass tube 14 mm inside diameter and 195 mm long (volume, 30 cc), constricted at one end to a small glass stopcock. Below the stopcock, attached by means of a rubber connection and inserted into the stopcock tubing, is a 250 mm length of 3 mm outside diameter glass tubing. This tubing is to reach to the bottom of the gas apparatus container for the oxygen-absorbing solution. At the bottom of the larger tubing is a wad of fine, glass wool for filtering the solution. Twenty-five cc of 2 N KOH solution is poured into the tube, and somewhat more than ½ of the 15 gm of hydrosulfite is added. The tube is stoppered and shaken a few times. The solution is then run into the container, and a 2 cm layer of liquid petrolatum is simultaneously poured on to the surface. The second 25 cc of KOH solution and the remainder of the hydrosulfite are quickly added in a similar manner, and the absorbing solution is ready for use.

The useful oxygen-absorbing capacity of the hydrosulfite solution is greatly increased by this easy and rapid method of preparation.

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[1] D. D. Van Slyke and J. M. Neill, *Jour. Biol. Chem.*, 61: 523–573, 1924; D. D. Van Slyke, *Jour. Biol. Chem.*, 73: 121–126, 1927; D. D. Van Slyke and J. Sendroy, Jr., *Jour. Biol. Chem.*, 95: 509–529, 1932.

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